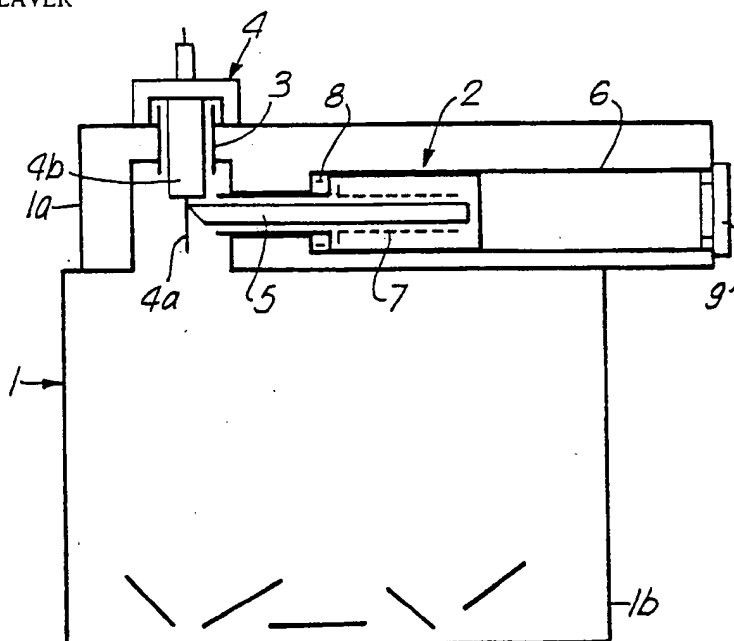


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(71) Applicant (for all designated States except US): BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB]; 81 Newgate Street, London EC1A 7AJ (GB).		Published With international search report. With amended claims and statement.	
(72) Inventors; and (75) Inventors/Applicants (for US only): REID, John, Ramsay [GB/GB]; 9 Coronation Road, Ipswich, Suffolk IP4 5EN (GB). SCARFE, John, Alan [GB/GB]; 40 Westmorland Road, Felixstowe, Suffolk IP11 9TE (GB).			

(54) Title: OPTICAL FIBRE CLEAVER



(57) Abstract

Apparatus is described for cleaving excess optical fibre from a fibre optic connector (15) of the type having a single optical fibre (15a) fixed within a ferrule (15b). The apparatus comprises a housing (11a, 11b and 11c) including a mount (14) for rotatably receiving the fibre optic connector, and a blade (13) for scoring a line of weakening in the cladding of the optical fibre (15a) close to the ferrule (15b). The blade (13) is mounted within the housing (11a, 11b, 11c) for reciprocal movement generally transversely to the longitudinal axis of the connector (15). The blade (13) is biased towards a position in which its tip (13a) contacts the fibre cladding when the connector (15) is positioned in the mount (14).

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OPTICAL FIBRE CLEAVER

This invention relates to apparatus for, and a method of, cleaving an optical fibre, and in particular to a cleaver for use in terminating fibre optic connectors.

The need to install large numbers of fibre links within buildings has prompted concern about the amount of time and skill required to terminate fibre optic connectors in the field. The termination of connectors has two main stages, namely the inserting and fixing (using glue) of the fibre within the connector, and the cleaving and polishing of the fibre protruding from the front face. Currently, the most user intensive portion is the front face finishing stage which has two main parts, namely:-

- 1) Fast removal using coarse polishing paper of the majority of the excess fibre; and
- 2) The much slower removal of the last few microns using fine polishing paper.

Both stages may entail the use of more than one paper.

Most of the work and skill is required to grind the fibre and excess glue to the correct shape and length for the final polish. This grinding is highly critical, too much grinding destroying the end of the fibre, too little leaving a large amount of material to be removed by the fine polish stage. The speed of this process is reduced by the presence of excess glue which is required to support the fibre during the grinding process. In practice, because it is standard procedure to have a relatively long piece of fibre protruding from the front face of a connector ferrule, it is necessary to smear the fibre end liberally with glue prior to pushing it into the ferrule. The protruding portion of the fibre is then supported by a mass of glue. In some cases, it is even

necessary to add extra glue (either to the ferrule front face or to the fibre end) in order to provide sufficient support for the fibre during the subsequent grinding operation. The amount of glue and fibre is highly variable, and so requires constant feedback to determine when to change to the second stage of the finishing process.

Once the grinding stage is complete, the final polish can proceed. This stage is relatively operator independent, in so far as the connector itself limits the amount of polishing that can take place. Therefore, in order to simplify the termination of fibre optic connectors, it is the first stage of the finishing process that requires simplification.

The present invention provides apparatus for cleaving excess optical fibre from a fibre optic connector of the type having a single optical fibre fixed within a ferrule, the apparatus comprising a housing including mounting means for rotatably receiving the fibre optic connector, and a blade for scoring a line of weakening in the cladding of the optical fibre close to the ferrule, wherein the blade is mounted within the housing for reciprocal movement generally transversely to the longitudinal axis of the connector, and wherein the blade is biased towards a position in which its tip contacts the fibre cladding when the connector is positioned in the mounting means.

Advantageously, the blade is spring biased towards said position. Preferably, the blade is mounted in a support, the support being mounted for reciprocal movement, generally transversely to the longitudinal axis of the connector, within the housing. The support may be spring biased in a direction tending to move the support and the blade away from said position. Conveniently, the

spring biasing the support has a higher rating than the spring biasing the blade.

In a preferred embodiment, a generally cylindrical mount constitutes the mounting means, the connector being a loose sliding and rotatable fit within the mount, whereby the connector can be rotated through 360° relative to the housing, when the connector is fully inserted into the mount, so that the tip of the blade scores a line of weakening right round the fibre cladding. Preferably, the arrangement is such that, when the connector is fully inserted into the mounting means and the support is moved towards said position, the tip of the blade contacts the fibre cladding about 50µm from the ferrule.

In another preferred embodiment, the blade is mounted in a support, the support being mounted within the housing by resilient support means in such a manner that the blade is mounted for reciprocal movement, generally transversely to the longitudinal axis of the connector. In this case, a generally cylindrical mount may constitute the mounting means, the connector being a rotatable fit within the mount, whereby the housing can be rotated through 360° relative to the connector, when the connector is fully inserted into the mount, so that the tip of the blade scores a line of weakening right round the fibre cladding. Advantageously, the connector is an interference fit within the mount, and the mount is made of a low-friction material such as polytetrafluoroethylene. Preferably, the arrangement is such that, when the connector is fully inserted into the mounting means and the blade is moved towards said position, the tip of the blade contacts the fibre cladding about 50µm from the ferrule.

Conveniently, the housing defines a receptacle for receiving cleaved portions of optical fibre.

The invention also provides a method of cleaving excess optical fibre from a fibre optic connector of the type having a single optical fibre fixed within a ferrule, the method comprising the steps of positioning the connector within a mount in a housing, forcing the tip of a blade against the fibre cladding at a position close to the ferrule, scoring a line of weakening in the fibre cladding using the tip of the blade, and removing the connector from the mount with the tip of the blade biased against the fibre, whereby the fibre is cleaved at the line of weakening as the moment of the biasing force of the tip of the blade acting at the line of weakening increases to a predetermined value as the point of action of the tip on the fibre moves along the fibre towards the free end thereof and away from the line of weakening.

Advantageously, the connector is rotated, preferably through 360° relative to the housing whereby the tip of the blade scores said line of weakening. Alternatively, the housing is rotated, preferably through 360°, relative to the connector whereby the tip of the blade scores said line of weakening.

The method may further comprise the step of collecting cleaved excess optical fibre within a receptacle defined by the housing.

The invention further provides a method of forming a fibre optic termination, the method comprising the steps of introducing an optical fibre into the bore of a fibre support, fixing the fibre within the bore so that the end of the fibre protrudes from the bore, severing the protruding portion of the fibre at a distance from the support of no more than 70µm, and polishing the severed fibre end to a finished length.

Preferably, the fibre is fixed within the bore of the support by means of an adhesive, the adhesive being positioned substantially entirely within the bore.

Two forms of optical fibre cleaver, each of which is constructed in accordance with the invention, will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:-

- Figure 1 is a schematic vertical cross-section taken through the first form of cleaver;
- Figures 2a to 2e are sketches showing the operation of the cleaver of Fig. 1; and
- Figure 3 is a schematic sectional elevation of the second form of cleaver.

Referring to the drawings, Figure 1 shows a cleaver having a casing 1, the upper portion 1a of which houses a cleaving tool indicated generally by the reference numeral 2, and the lower portion 1b of which constitutes a receptacle for waste fibre removed from optical fibre connectors. The upper portion 1a of the casing 1 is provided with a mount 3 for an optical fibre connector 4 of the type in which a single fibre 4a is glued into a ferrule-type connector 4b. The mount 3 is such that, in use, the connector 4 is supported by the upper portion 1a of the casing 1 with the fibre 4a generally vertical.

The cleaving tool 2 includes a diamond-tipped blade 5 mounted for reciprocal movement in a generally-horizontal direction within a cleaver housing 6. The cleaver housing 6 is mounted for limited reciprocal movement in a generally horizontal direction within the upper portion 1a of the casing 1. The blade 5 is biased outwardly (that is to say towards the left as shown in Fig. 1) with respect to its housing 6 by means of a spring 7, and the housing 6 is biased outwardly (that is to say towards the right as

shown in Fig. 1) with respect to the casing 1 by means of a spring 8. The spring 8 has a higher rating than the spring 7. The housing 6 can be pushed into the casing 1, against the force of the spring 8, by means of a knob 9. A latch (not shown) can be used to lock the housing 6 in this position. With the housing 6 pushed into the casing 1 and with the blade 5 in its fully-outwardly-biased position, the tip of the blade extends into the centre of the region below the mount 3. Thus, when a connector 4 is supported within the mount 3, the tip of the blade 5 is forced against the fibre 4a by the biasing action of the spring 7. The arrangement is such that the tip of the blade 5 contacts the fibre 4a about 50 $\mu$ m from the end of the ferrule 4b.

The method of operation of the cleaver will now be described with reference to Figure 2. Firstly, a connector 4 is placed within the mount 3 (see Figure 2a) in such a manner that the fibre 4a is spaced from the tip of the blade 5, the housing 6 being fully-outwardly-biased by the spring 8. The housing 6 is then inserted into the casing 1, against the force of the spring 8, until the tip of the blade 5 rests against the fibre 4a with the spring 7 slightly compressed (see Fig. 2b). This does not result in a cleaving action. The connector 3 is then rotated through 360° relative to the casing 1 (see Figure 2c), thus causing the tip of the blade 5 to score a line of weakening right round the cladding of the fibre 4a. The connector 4 is then removed from the mount 3. As the ferrule 4b is withdrawn, the tip of the blade engages further down along the fibre 4a (see Figure 2d), thereby imparting a greater leverage on the line of weakening in the fibre cladding. This increasing leverage eventually stresses the fibre cladding to a sufficient degree to form a cleave along the line of weakening. The cleaved fibre then falls into the receptacle 1b.

In order to finish the termination of the connector 4, the operator can now proceed to the polishing stage, without the need to place waste fibre in a container, or to grind the fibre down to a required length.

Figure 3 shows a low-cost version of the type of cleaver described above. This cleaver has a three-part casing 11a, 11b and 11c. The lower casing part 11a constitutes a receptacle for waste fibre removed from optical fibre connectors. The middle casing part 11b slidably supports a blade retracting bar 12, and the upper casing part 11c is constituted by a lid which supports a tungsten carbide blade 13 (in a manner to be described below), and defines a ferrule support portion 14. The three casing parts 11a, 11b and 11c are fixed together by means of screws (not shown). The ferrule support portion 14 provides a mount for an optical fibre connector 15 of the type in which a single fibre 15a is glued into a ferrule-type connector 15b. The casing 11a, 11b and 11c has a rectangular cross-section, and has dimensions of 2cm by 1.5cm by 2cm.

The blade 13 is supported beneath the upper casing part 11c by a pair of resilient mounting arms 16a and 16b. The arms 16a and 16b are made of a resilient plastics material such as neoprene, and are directly moulded onto the blade 13. The arms 16a and 16b are firmly gripped within complementary apertures (not shown) formed in the upper casing part 11c. The blade retracting bar 12 is constituted by length of strong wire, which is bent to by-pass the connector 15 and the arm 16a, and which acts on the arm 16b. The resilient arms 16a and 16b are such as to bias the blade 13 so that its tip 13a presses against the fibre 15a of the connector 15 when the connector is mounted in the support portion 14 (that is to say the arms bias the blade towards the left as shown in

the drawing). The arrangement is such that the tip 13a of the blade 13 contacts the fibre 15a about 50 $\mu$ m from the end of the ferrule 15b, with the blade resting against the end face of the ferrule.

The method of operation of the cleaver of Figure 3 will now be described. Firstly, the blade retracting bar 12 is pushed into the casing and against the resilient arm 16b. The arms 16a and 16b bend under this force, thereby retracting the blade 13 and allowing a connector 15 to be placed within the support portion 14 without the protruding fibre 15a coming into contact with the tip 13a of the blade. The bar 12 is then released allowing the blade 13 to move to the left (as shown in the drawing) under the biasing force of the resilient arms 16a and 16b, so that its tip 13a rests against the fibre 15a. The end face of the ferrule 15b acts as a guide for the blade 13, thereby ensuring accurate cleaving without the need for a complicated alignment mechanism. The resilient arms 16a and 16b are such that the blade tip 13a is pressed against the fibre 15a with a force that is sufficient to scratch the fibre but not sufficient to break it.

The cleaver is then rotated several times with respect to the connector 15, thus causing the blade tip 13a to score a line of weakening right round the cladding of the fibre 15a. The connector 15 is then removed from the support portion 14. As the ferrule 15b is withdrawn, the blade tip 13a engages further down along the fibre 15a, thereby imparting a greater leverage on the line of weakening in the fibre cladding. This increased leverage eventually stresses the fibre cladding to a sufficient degree to form a cleave along the line of weakening. The cleaved fibre then falls into the receptacle 11a.

In order to finish the termination of the connector 15, the operator can now proceed to the polishing stage,

without the need to place waste fibre in a container, or to grind the fibre down to a required length.

The ferrule support portion 14 is preferably made of polytetrafluoroethylene (ptfe). This enables the ferrule 15b to be an interference fit within the support portion 14, thereby minimising ferrule wobble without restricting relative rotation between the ferrule and the support portion. As ptfe is easy to machine, and is mouldable, the upper casing part 11c and the ferrule support portion 14 can be formed as a one-piece member.

It will be apparent that modifications could be made to the cleaver described above with reference to Figure 3. For example, the casing could be of two-part construction, in which case the lower and middle casing parts would be combined. The casing could also be of cylindrical construction rather than of rectangular construction. This would facilitate rotation of the cleaver relative to the ferrule, and would allow the casing parts to be screw-threaded together. It would also be possible to make the casing of plastics material, which would facilitate production of the device. In this case, the cleaver would be made the same size as a pocket pencil sharpener, and the cleaver itself would be a disposable item.

In another modified form of cleaver, the lower casing part 11a would be lined with an adhesive coating, so that severed fibre ends would adhere to the coating, thereby preventing such fibre ends accumulating in the working area of the blade 13. If fibre ends are found to escape from the ferrule support portion 14 when the cleaver is not in use, this could be closed by means of a simple plug.

It will be apparent that each of the cleavers described above has a number of advantages. In particular, fibre is cleaved extremely close (about

50 $\mu$ m) to the ferrule of the associated connector, allowing a significant improvement in the subsequent time needed for polishing. This leads to a substantial reduction in the time required to terminate optical fibres as compared with known termination methods. Each cleaver is also of simple construction, and is easy to operate, the deflection of the fibre being achieved automatically on removal of the connector. Another advantage of these tools is that scrap fibre (a dangerous item) is captured automatically within the tool casing. The cleavers are, therefore, particularly suitable for use in the field.

An important further advantage of the cleaver of Figure 3 is that the cleaver itself can easily be rotated relative to the associated connector, rather than having to rotate the connector relative to the cleaver (which could cause undesirable twisting of the optical fibre) as is necessary with the cleaver of Figures 1 and 2.

CLAIMS

1. Apparatus for cleaving excess optical fibre from a fibre optic connector of the type having a single optical fibre fixed within a ferrule, the apparatus comprising a housing including mounting means for rotatably receiving the fibre optic connector, and a blade for scoring a line of weakening in the cladding of the optical fibre close to the ferrule, wherein the blade is mounted within the housing for reciprocal movement generally transversely to the longitudinal axis of the connector, and wherein the blade is biased towards a position in which its tip contacts the fibre cladding when the connector is positioned in the mounting means.
2. Apparatus as claimed in claim 1, wherein the blade is spring biased towards said position.
3. Apparatus as claimed in claim 1 or claim 2, wherein the blade is mounted in a support, the support being mounted for reciprocal movement, generally transversely to the longitudinal axis of the connector, within the housing.
4. Apparatus as claimed in claim 3, wherein the support is spring biased in a direction tending to move the support and the blade away from said position.
5. Apparatus as claimed in claim 4, wherein the spring biasing the support has a higher rating than the spring biasing the blade.

6. Apparatus as claimed in any one of claims 1 to 5, wherein a generally cylindrical mount constitutes the mounting means, the connector being a loose sliding and rotatable fit within the mount, whereby the connector can be rotated through 360° relative to the housing, when the connector is fully inserted into the mount, so that the tip of the blade scores a line of weakening right round the fibre cladding.

7. Apparatus as claimed in any one of claims 1 to 6, wherein the arrangement is such that, when the connector is fully inserted into the mounting means and the support is moved towards said position, the tip of the blade contacts the fibre cladding about 50µm from the ferrule.

8. Apparatus as claimed in claim 1, wherein the blade is mounted in a support, the support being mounted within the housing by resilient support means in such a manner that the blade is mounted for reciprocal movement, generally transversely to the longitudinal axis of the connector.

9. Apparatus as claimed in claim 8, wherein a generally cylindrical mount constitutes the mounting means, the connector being a rotatable fit within the mount, whereby the housing can be rotated through 360° relative to the connector, when the connector is fully inserted into the mount, so that the tip of the blade scores a line of weakening right round the fibre cladding.

10. Apparatus as claimed in claim 9, wherein the connector is an interference fit within the mount, and the mount is made of a low-friction material such as polytetrafluoroethylene.

11. Apparatus as claimed in any one of claims 8 to 10, wherein the arrangement is such that, when the connector is fully inserted into the mounting means and the blade is moved towards said position, the tip of the blade contacts the fibre cladding about 50 $\mu$ m from the ferrule.

12. Apparatus as claimed in any one of claims 1 to 11, wherein the housing defines a receptacle for receiving cleaved portions of optical fibre.

13. Cleaving apparatus substantially as hereinbefore described with reference to, and as illustrated by, Figs 1 and 2 or Fig. 3 of the accompanying drawings.

14. A method of cleaving excess optical fibre from a fibre optic connector of the type having a single optical fibre fixed within a ferrule, the method comprising the steps of positioning the connector within a mount in a housing, forcing the tip of a blade against the fibre cladding at a position close to the ferrule, scoring a line of weakening in the fibre cladding using the tip of the blade, and removing the connector from the mount with the tip of the blade biased against the fibre, whereby the fibre is cleaved at the line of weakening as the moment of the biasing force of the tip of the blade acting at the line of weakening increases to a predetermined value as the point of action of the tip on the fibre moves along the fibre towards the free end thereof and away from the line of weakening.

15. A method as claimed in claim 14, wherein the connector is rotated relative to the housing whereby the tip of the blade scores said line of weakening.

16. A method as claimed in claim 15, wherein the connector is rotated through 360° relative to the housing.

17. A method as claimed in claim 14, wherein the housing is rotated relative to the connector whereby the tip of the blade scores said line of weakening.

18. A method as claimed in claim 17, wherein the housing is rotated through 360° relative to the connector.

19. A method as claimed in any one of claims 14 to 18, further comprising the step of collecting cleaved excess optical fibre within a receptacle defined by the housing.

20. A cleaving method substantially as hereinbefore described with reference to the accompanying drawings.

21. A method of forming a fibre optic termination, the method comprising the steps of introducing an optical fibre into the bore of a fibre support, fixing the fibre within the bore so that the end of the fibre protrudes from the bore, severing the protruding portion of the fibre at a distance from the support of no more than 70µm, and polishing the severed fibre end to a finished length.

22. A method as claimed in claim 21, wherein the fibre is fixed within the bore of the suport by means of an adhesive, the adhesive being positioned substantially entirely within the bore.

## AMENDED CLAIMS

[received by the International Bureau on 18 February 1991 (18.02.91);  
original claim 14 replaced by amended claims 14 and 15;  
claims 15-22 renumbered as claims 16-23;  
other claims unchanged  
(3 pages)]

10. Apparatus as claimed in claim 9, wherein the connector is an interference fit within the mount, and the mount is made of a low-friction material such as polytetrafluoroethylene.
11. Apparatus as claimed in any one of claims 8 to 10, wherein the arrangement is such that, when the connector is fully inserted into the mounting means and the blade is moved towards said position, the tip of the blade contacts the fibre cladding about 50µm from the ferrule.
12. Apparatus as claimed in any one of claims 1 to 11, wherein the housing defines a receptacle for receiving cleaved portions of optical fibre.
13. Cleaving apparatus substantially as hereinbefore described with reference to, and as illustrated by, Figs 1 and 2 or Fig. 3 of the accompanying drawings.
14. A method of cleaving excess optical fibre from a fibre optic connector of the type having a single optical fibre fixed within a ferrule, the method comprising the steps of positioning the connector within a mount in a housing, forcing the tip of a blade against the fibre cladding at a position close to the ferrule, scoring a line of weakening in the fibre cladding using the tip of the blade, and cleaving the fibre at the line of weakening by applying a force to the free end portion of the fibre.

15. A method as claimed in claim 14, further comprising the step of removing the connector from the mount with the tip of the blade biased against the fibre, whereby the fibre is cleaved at the line of weakening as the moment of the biasing force of the tip of the blade acting at the line of weakening increases to a predetermined value as the point of action of the tip on the fibre moves along the fibre towards the free end thereof and away from the line of weakening.

16. A method as claimed in claim 14 or claim 15, wherein the connector is rotated relative to the housing whereby the tip of the blade scores said line of weakening.

17. A method as claimed in claim 16, wherein the connector is rotated through 360° relative to the housing.

18. A method as claimed in claim 14 or claim 15, wherein the housing is rotated relative to the connector whereby the tip of the blade scores said line of weakening.

19. A method as claimed in claim 18, wherein the housing is rotated through 360° relative to the connector.

20. A method as claimed in any one of claims 14 to 19, further comprising the step of collecting cleaved excess optical fibre within a receptacle defined by the housing.

21. A cleaving method substantially as hereinbefore described with reference to the accompanying drawings.

22. A method of forming a fibre optic termination, the method comprising the steps of introducing an optical fibre into the bore of a fibre support, fixing the fibre within the bore so that the end of the fibre protrudes from the bore, severing the protruding portion of the

fibre at a distance from the support of no more than 70µm, and polishing the severed fibre end to a finished length.

23. A method as claimed in claim 22, wherein the fibre is fixed within the bore of the suport by means of an adhesive, the adhesive being positioned substantially entirely within the bore.

STATEMENT UNDER ARTICLE 19

Claim 14 has been amended so that its scope is more similar to that of Claim 1.

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Fig.1.

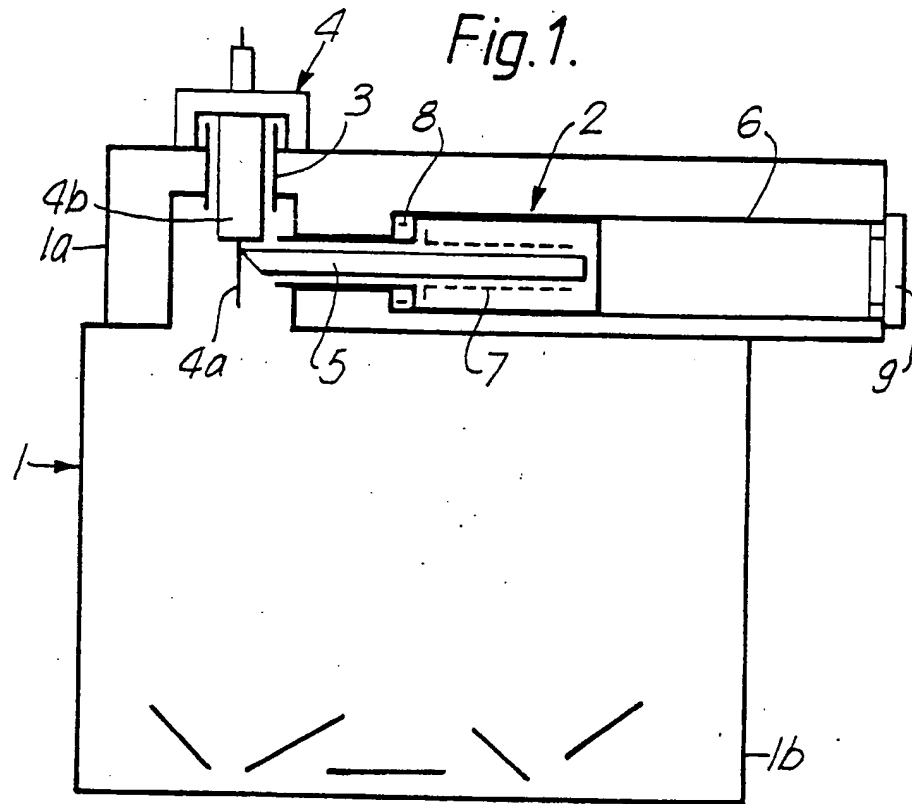
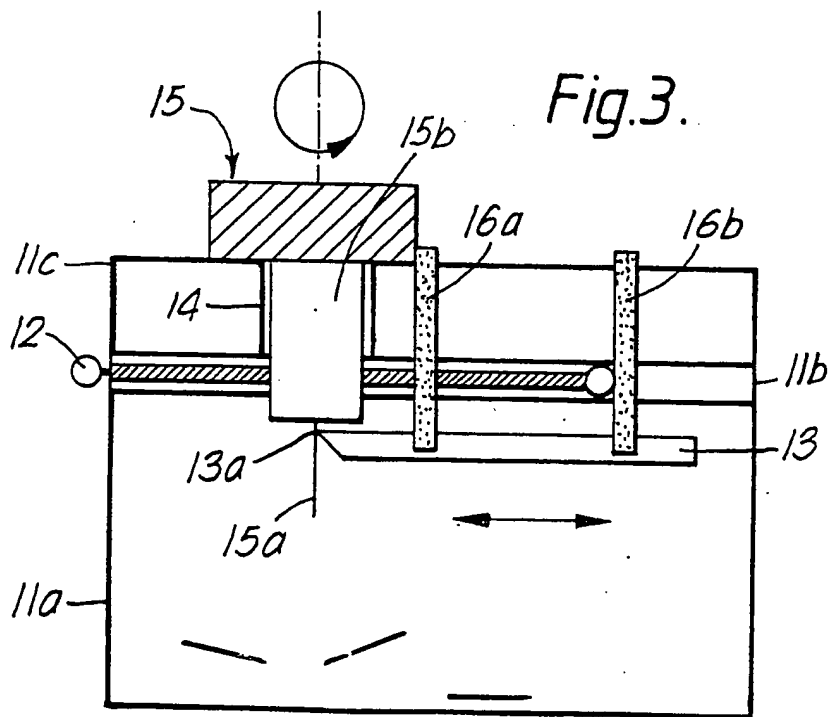


Fig.3.



SUBSTITUTE SHEET

2/2

Fig. 2a.

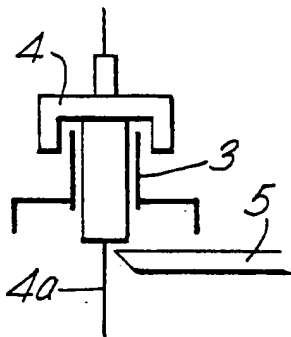


Fig. 2b.

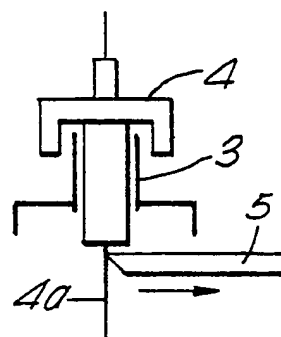


Fig. 2c.

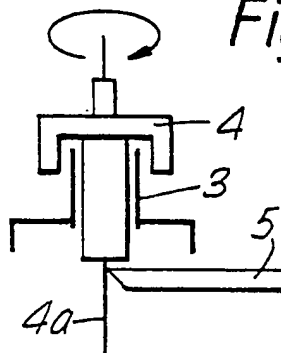


Fig. 2d.

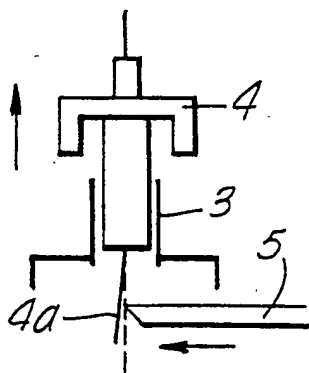
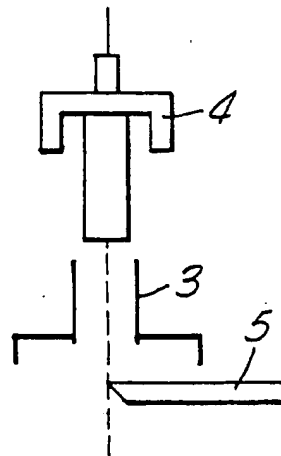


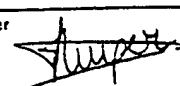
Fig. 2e.



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 90/01296

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>5</sup> : G 02 B 6/25, G 02 B 6/38		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System :	Classification Symbols	
IPC <sup>5</sup> : G 02 B 6/00		
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> *		
Category *	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	EP, A, 0287474 (SOURIAU ET CIE) 19 October 1988 see the whole document	1,2,3,14
---		
A	GB, A, 2046242 (THE SECRETARY OF STATE FOR DEFENCE) 12 November 1980 see the whole document	1,2,6
---		
A	Patent Abstracts of Japan, volume 9, no. 257 (P-396)(1980), 15 October 1985, & JP, A, 60107601 (FUJITSU), 13 June 1985 see the whole document	1,12
---		
A	US, A 4464817 (K. JOHNSON et al.) 14 August 1984 see figures 8,10A-10F; column 6, lines 65-68; column 7, lines 1-37	1
-----		
<p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
30th October 1990	28 JAN 1991	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	Mme N. KUIPER 	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE :

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claim numbers ..... because they relate to parts of the International application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically
  
3. ☐ Claim numbers ..... because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING :

This International Searching Authority found multiple inventions in this international application as follows:

1. Claims 1-20: Apparatus and method of cleaving optical fibre placed in a fibre optic connector
2. Claims 21,22: Method of forming a fibre optic termination

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
  
3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:  
1-20
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the international Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.

GB 9001296  
SA 39310

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 21/01/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0287474	19-10-88	FR-A- 2613972	21-10-88
GB-A- 2046242	12-11-80	None	
US-A- 4464817	14-08-84	CA-A- 1224655	28-07-87
		EP-A, B 0099623	01-02-84
		JP-A- 58215615	15-12-83